PHENIX Vertex Finding

16-Jun-2003

John P. Sullivan

Why should you care if the MVD is there?

Some answers:

- Precision vertex (~0.1 mm)
- Multiplicity
- reaction plane
- fluctuations
- dN/dη and dN/dη/dϕ
- other uses?

Mainly relevant to pp, dAu:

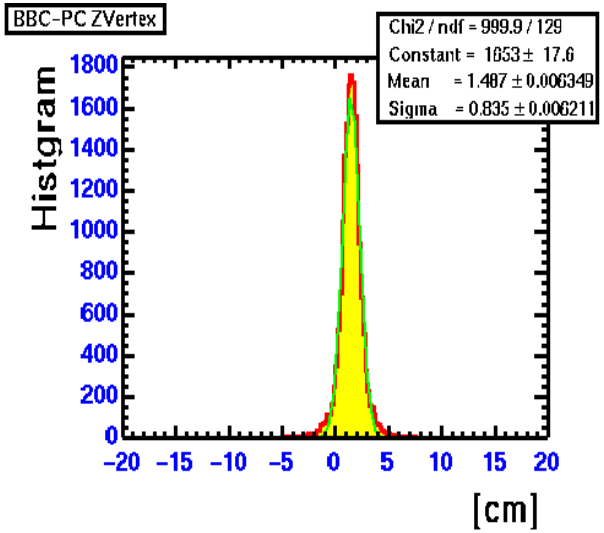
J/Ψ → μμ resolution without precision vertex ~200 MeV

J/Ψ → μμ resolution with precision vertex ~120 MeV

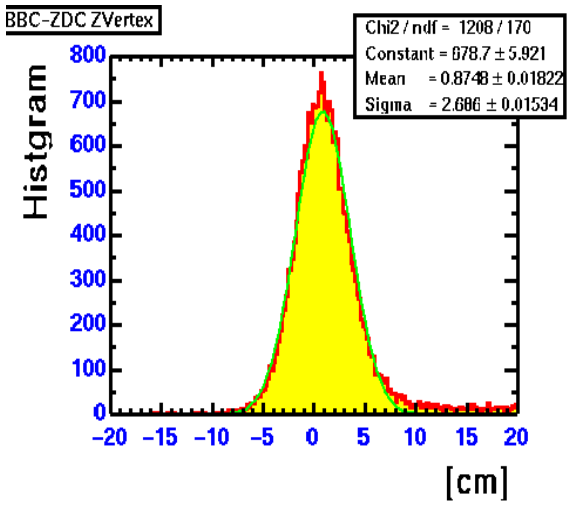
Ψ/Ψ' separation = 588 MeV

"precision vertex" means to within 1-2 cm.

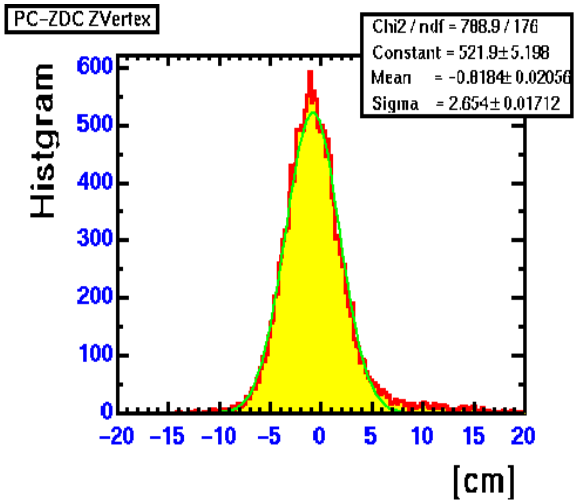
Resolution: RUN2 (Au+Au)



BBCZ - PCZ



BBCZ - ZDCZ



PCZ - ZDCZ

$$\sigma^2_{BBC-PC} = \sigma^2_{BBC} + \sigma^2_{PC}$$

$$\sigma^2_{BBC-ZDC} = \sigma^2_{BBC} + \sigma^2_{ZDC}$$

$$\sigma^2_{ZDC-PC} = \sigma^2_{ZDC} + \sigma^2_{PC}$$

Plots from Tomoaki Nakamura -- Phenix focus talk.

John Sullivan

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My solutions to the equations on the previous slide

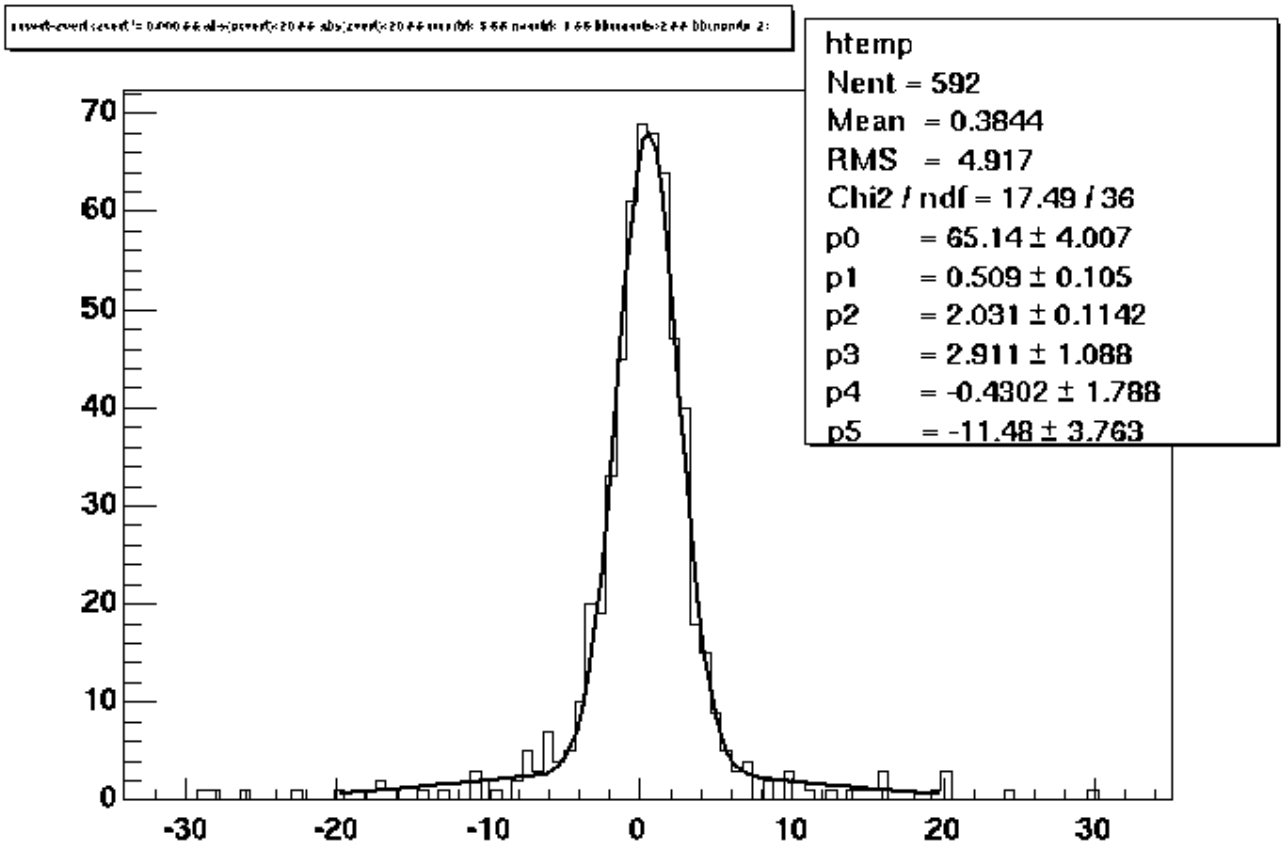
Au+Au data, run 2

σ_{BBC} = 0.66 +- 0.05 cm
σ_{PC} = 0.51 +- 0.06 cm
σ_{ZDC}=2.60 +- 0.01 cm

I assume this is for central events

Resolution of other detectors

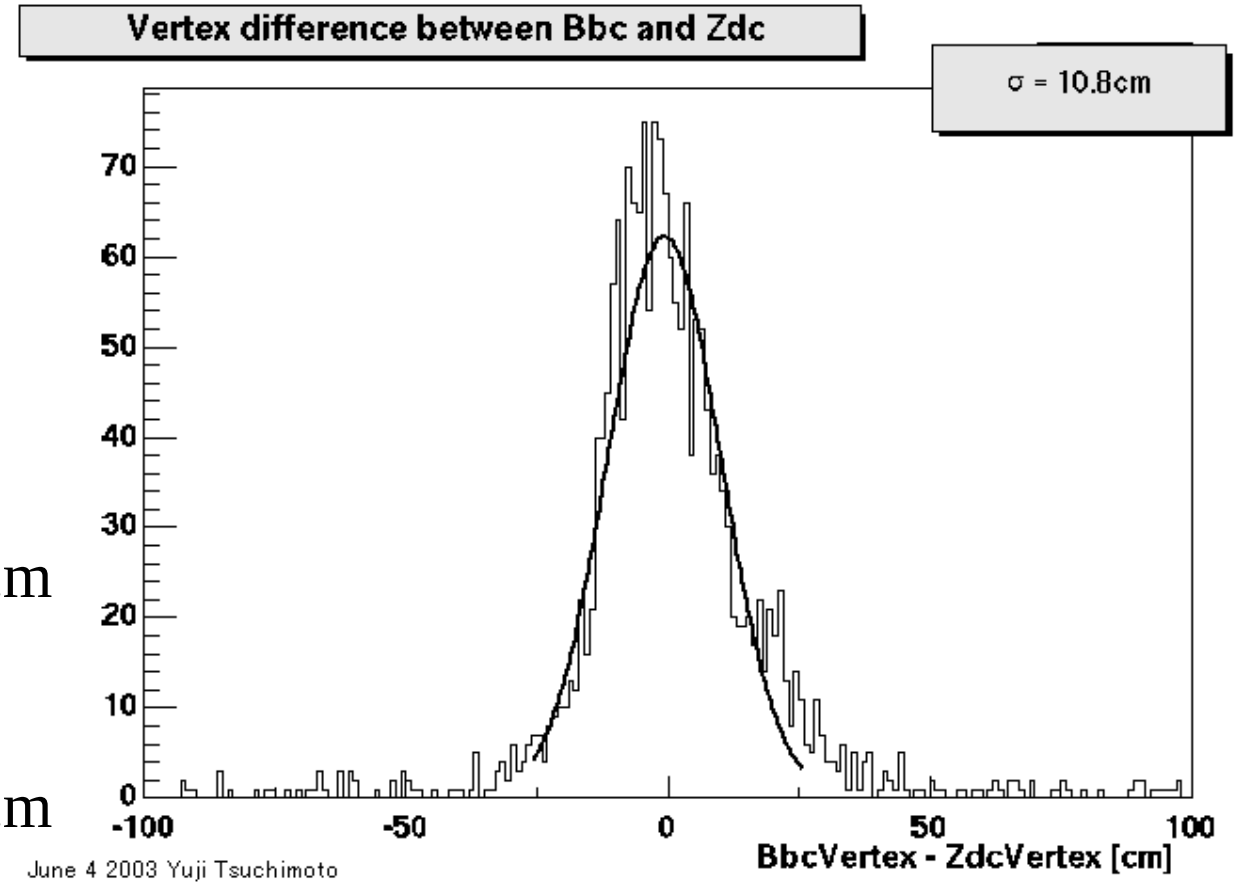
From David S,
pp run2 BBC-PC vertex difference
Width of narrow Gaussian
is about 2 cm --
versus 0.835 cm in AuAu.



Guess that both PC and BBC get worse by the same factor (vs. Au+Au) – σ_{BBC} ~ 1.6 cm and σ_{PC} ~ 1.2 cm. Good enough – it is only the efficiency (and tails on distribution) we need to worry about.

dAu – BBC – ZDC vertex difference

Plot from
Yuji Tsuchimoto
(Hiroshima)



d+Au:

$\sigma_{BBC\text{-}ZDC}$ = 10.8 cm

Au+Au:

$\sigma_{BBC\text{-}ZDC}$ = 2.69 cm

Assume BBC vertex resolution for d+Au is between p+p:

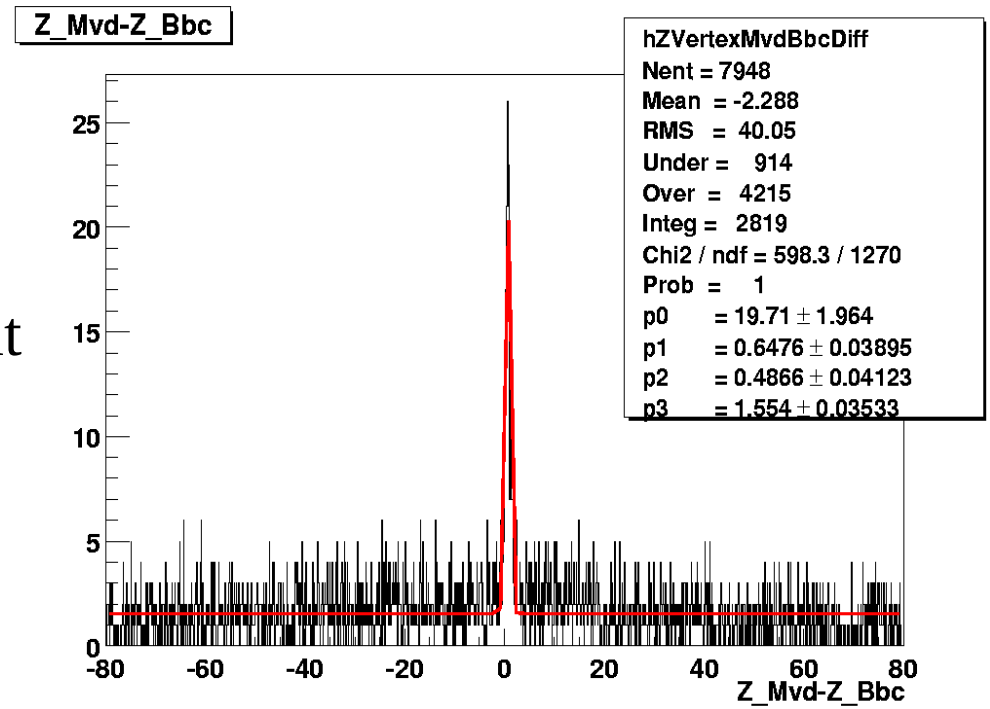
σ_{BBC} (Au+Au) ~ 0.7 cm and σ_{BBC} = 1.6 cm (guestimated p+p) – Implies ZDC resolution for d + Au ~ 10 cm.

Precision vertex

The vertex finding in the MVD did not work very well in year-2, but it sometimes found the vertex (difference between MVD-BBC):

From "standard" algorithms, $\sigma_{MVD} \sim 100$ μm

Needed ~5 particles to hit Inner+outer layer of MVD (1/3 of azimuth) to find the vertex – implies total multiplicity ~15.



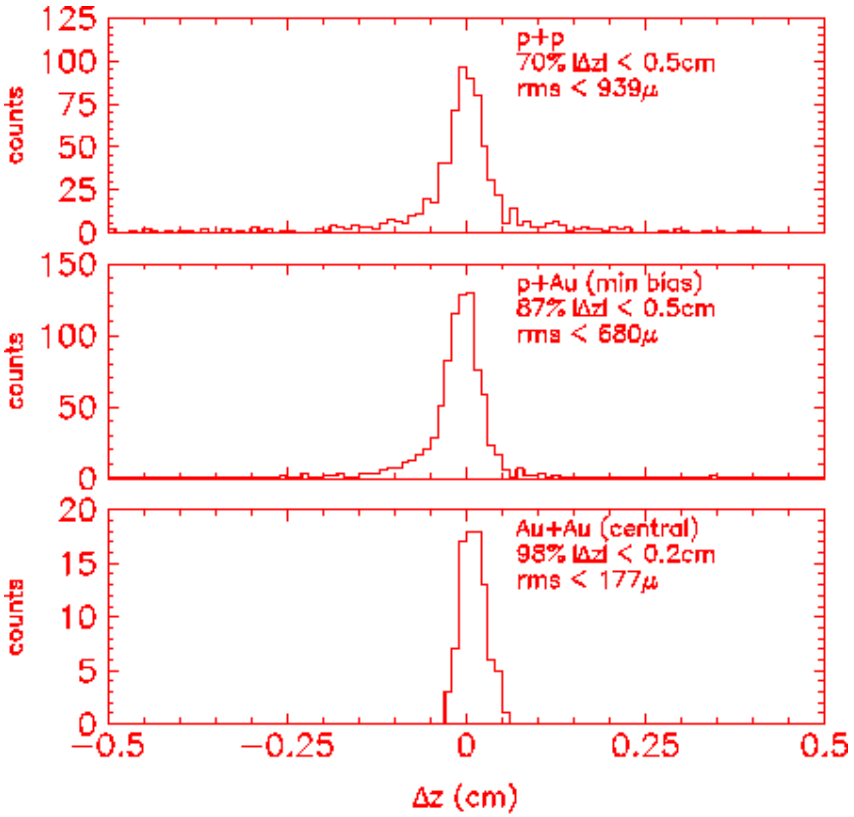
Width of narrow peak ~0.65 cm, ~same as BBC resolution, implying $\sigma_{MVD} << \sigma_{BBC}$ (as expected)

Simulated MVD efficiency and resolution

ε= 70%
rms = 939μ

ε= 87%
rms = 680μ

ε= 98%
rms = 177μ



pp

pAu

AuAu
(central)

This simulation is very old (<1997), but the basic result should still be more or less correct.

Summary of vertex resolutions

	p+p	d+A	Au+Au
σ_{BBC}	~1.6	0.7-1.6	0.7 cm
σ_{PC}	~1.2	0.5-1.2	0.5 cm
σ_{ZDC}	>10?	~10	2.6 cm
σ_{MVD}	0.1	0.07	<<0.65 cm

Numbers in blue are from simulations, others are measured, or at least estimated from data.

Vertex from other algorithms?

We should be able to find the vertex from the variations in the signal size (ADC value) vs. the angle of incidence:
Dz = distance from vertex = (5cm) $[(\text{ADC}/1\ \text{mip})^2 - 1]^{1/2}$

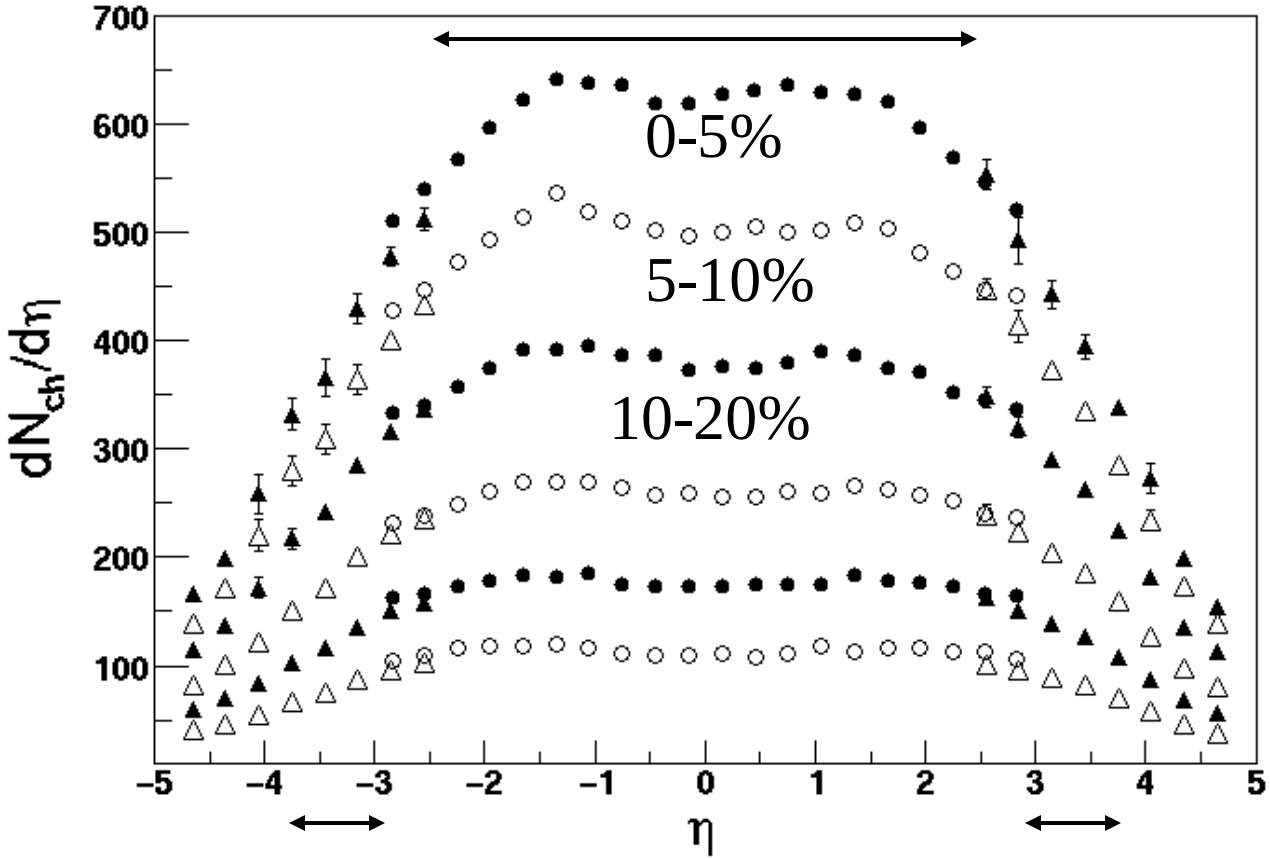
In simulations, algorithm can find the vertex to within a few cm (good enough for improving J/Ψ resolution) in events with very few hits in the MVD barrel.

Could be important for pp, pA, dA, where is might recover events without a BBC vertex.

MVD h coverage

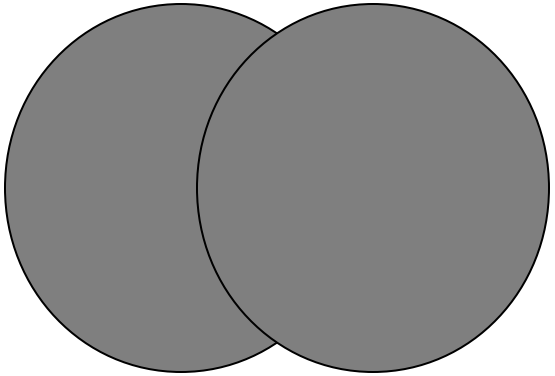
MVD: -2.5 < η < 2.5, Mult. ~ 3100 (~30K chan., but most particles hit multiple strips). Roughly 5 times BBC multiplicity.

AuAu
200 GeV,
Brahms
(PRL
2002)



BBC: 3 < | η | < 3.9 , Mult. ~350 * 0.9 * 2 = 630 (in 128 chan.)

Reaction plane



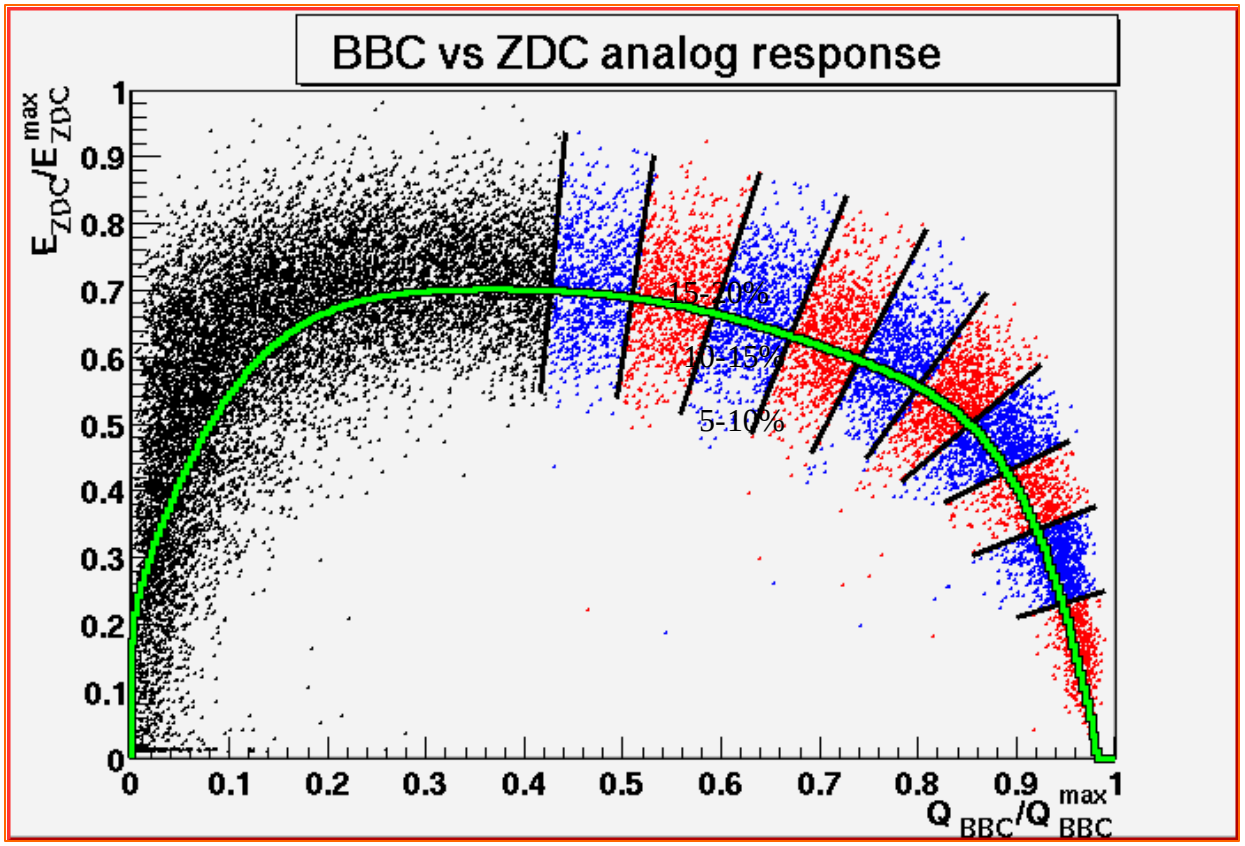
The MVD should be able to make good measurements of the reaction plane.

It sees ~5 times the number of particles as the BBC (with more channels).

This gives another interesting way to look at jet suppression and J/Ψ suppression vs. the length of excited matter traversed.

Mainly relevant to AA collisions

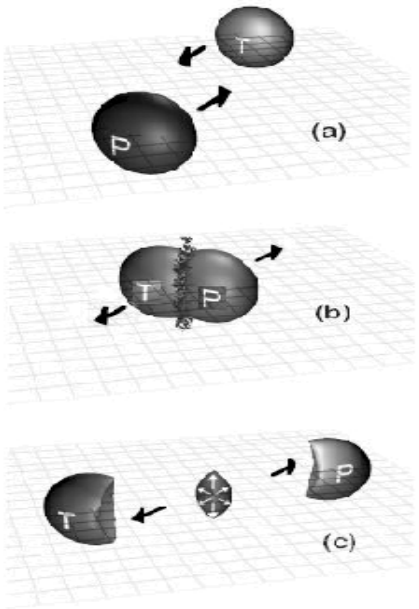
Centrality – now



ZDC/ZDC max

BBC/BBCmax

2R ← impact parameter ← 0



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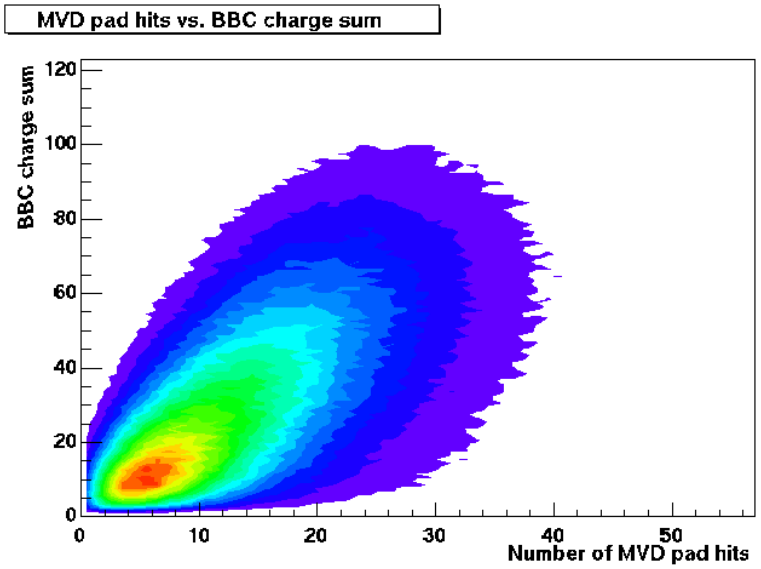
Centrality – in future ?

BBC charge sum

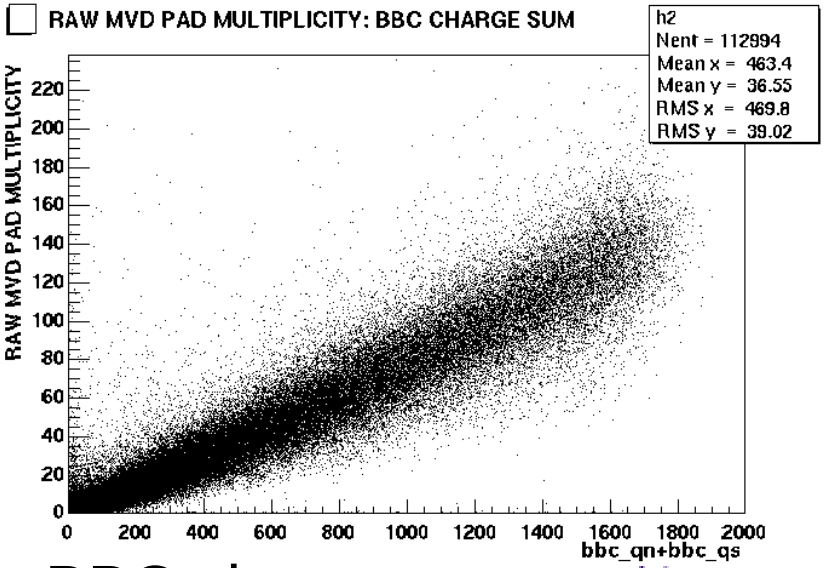


Run-3 d+Au

MVD pad hits

Year-2 Au+Au:

MVD pad mult



BBC charge sum

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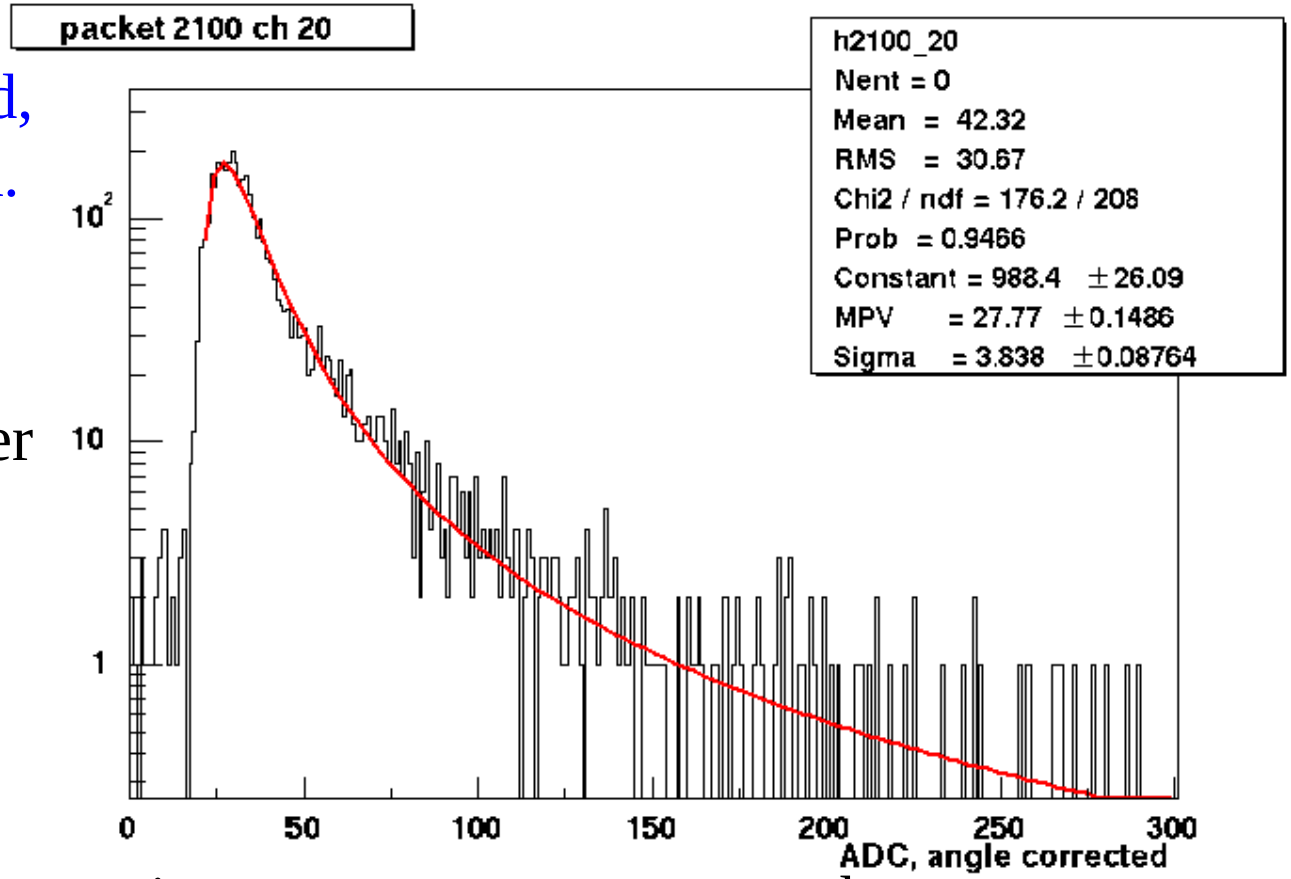
Landau fit to sample MVD pad detector channel

Plot is from Sangsu Ryu (Yonsei) – d+Au

Resolution is good,
Landau fit is good.



Wishful thinking?
Pad detectors cover
$\sim 1.8 < \eta < \sim 2.6$
(depending on
z_{vertex}) – if we can
consistently keep
this reolution,
maybe we can give a point on some muon arm tracks

Summary

In most cases, the BBC vertex resolution is good enough

MVD should be able to improve vertex resolution and vertex finding efficiency

I believe that measurements of the reaction plane will add a lot To the PHENIX physics program

From Shinichi Esumi

-- Simulation with rqmd2.4 at Au+Au 200GeV.

-- Resolution is worse than in reality because the flow (v2) is smaller in this generator and he did not apply the pt weighting for the central arm.

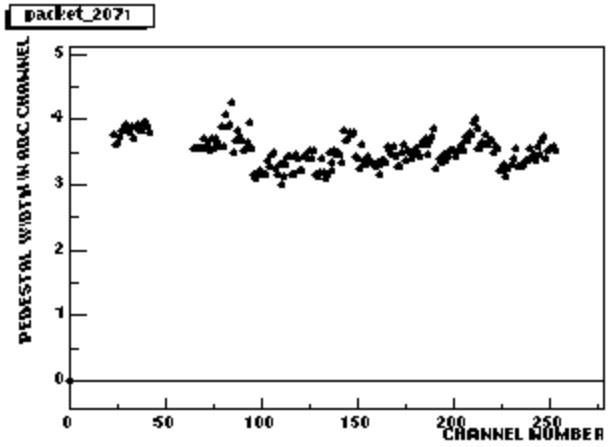
-- Can still take the factor how much we might gain with different configurations.

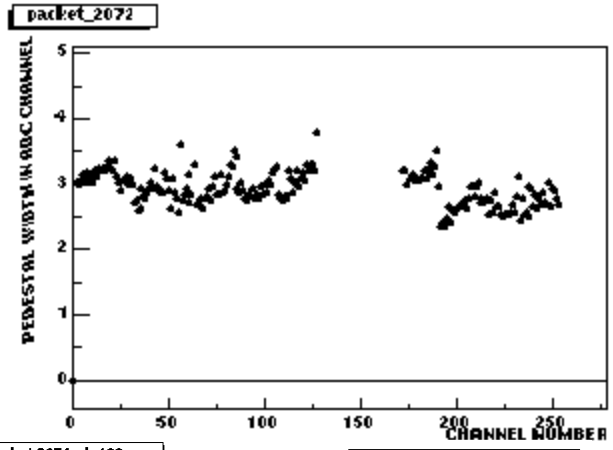
-- Resolution is for mid-central collisions.

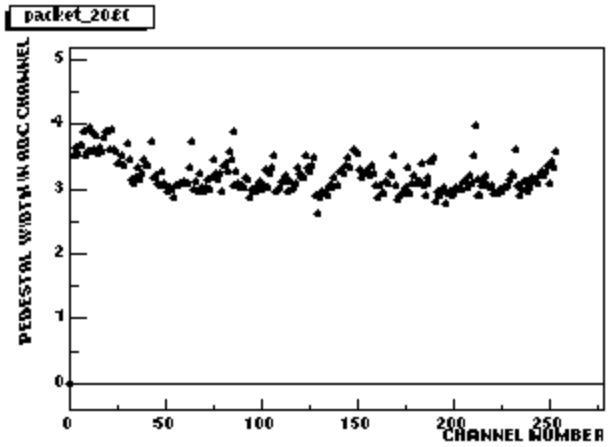
Configuration:	coverage:	$\langle \cos^2(\text{calc.-true}) \rangle$	
combined bbc	$\|\eta\|$ = [3.0-4.0]	0.22	(62 deg)
full central arm	$\|\eta\| < 0.35$	0.16	(66 deg)
hexagon	$\|\eta\| < 2.5$	0.42	(49 deg)

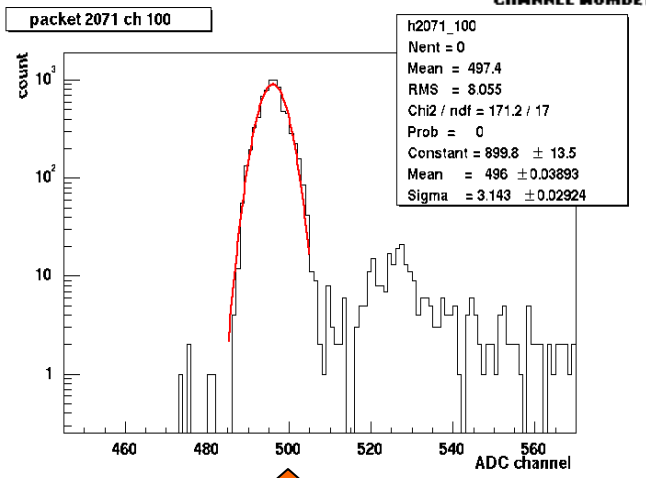
my guess: There are about 5 times as many particles in the MVD (vs BBC), so resolution will be ~ sqrt(5) better.

MVD pad pedestal









work by
Sangsu Ryu

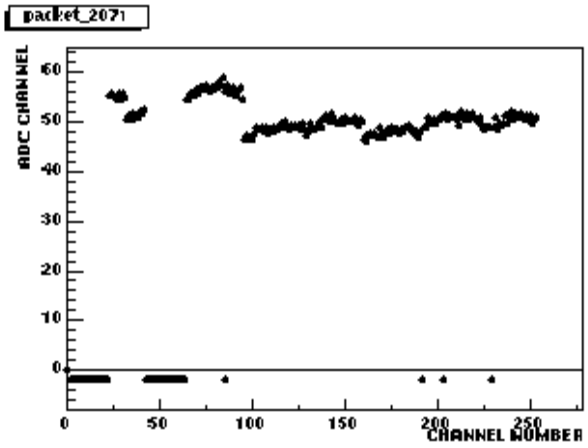
3 good pad
detectors

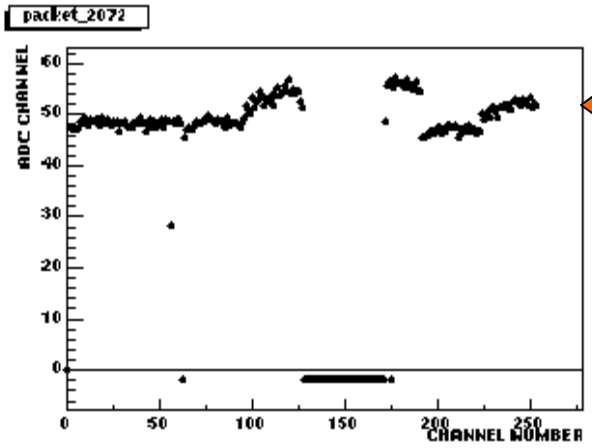
Year 2
Au+Au

Signal/noise ~ 45/4 ~ 11

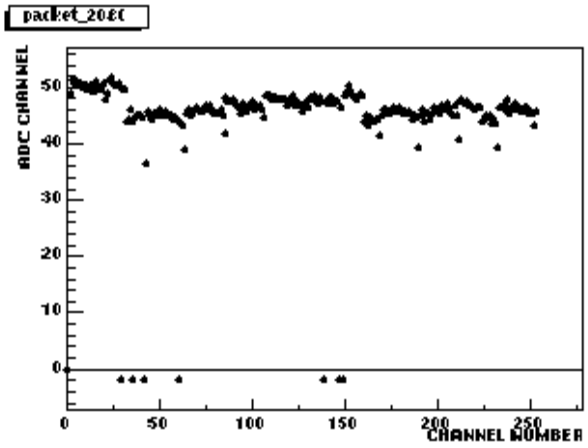
Pedestal

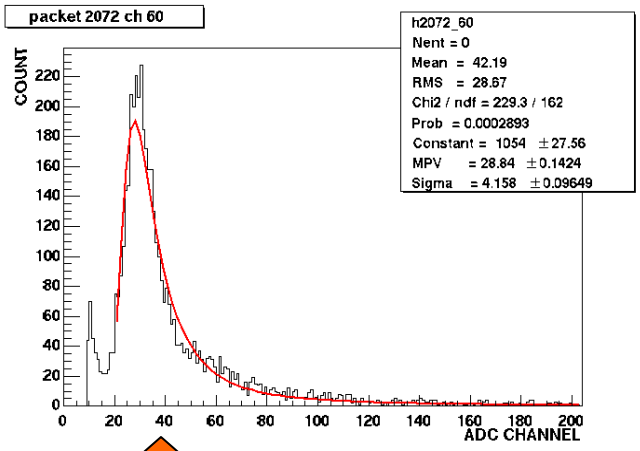
MVD pad mip distribution





Mean ADC corrected for incident angle, ~same for all chans.





Work from Sangsu Ryu/Yonsei

MIP signal, corrected for indent angle
Shows Landau distribution

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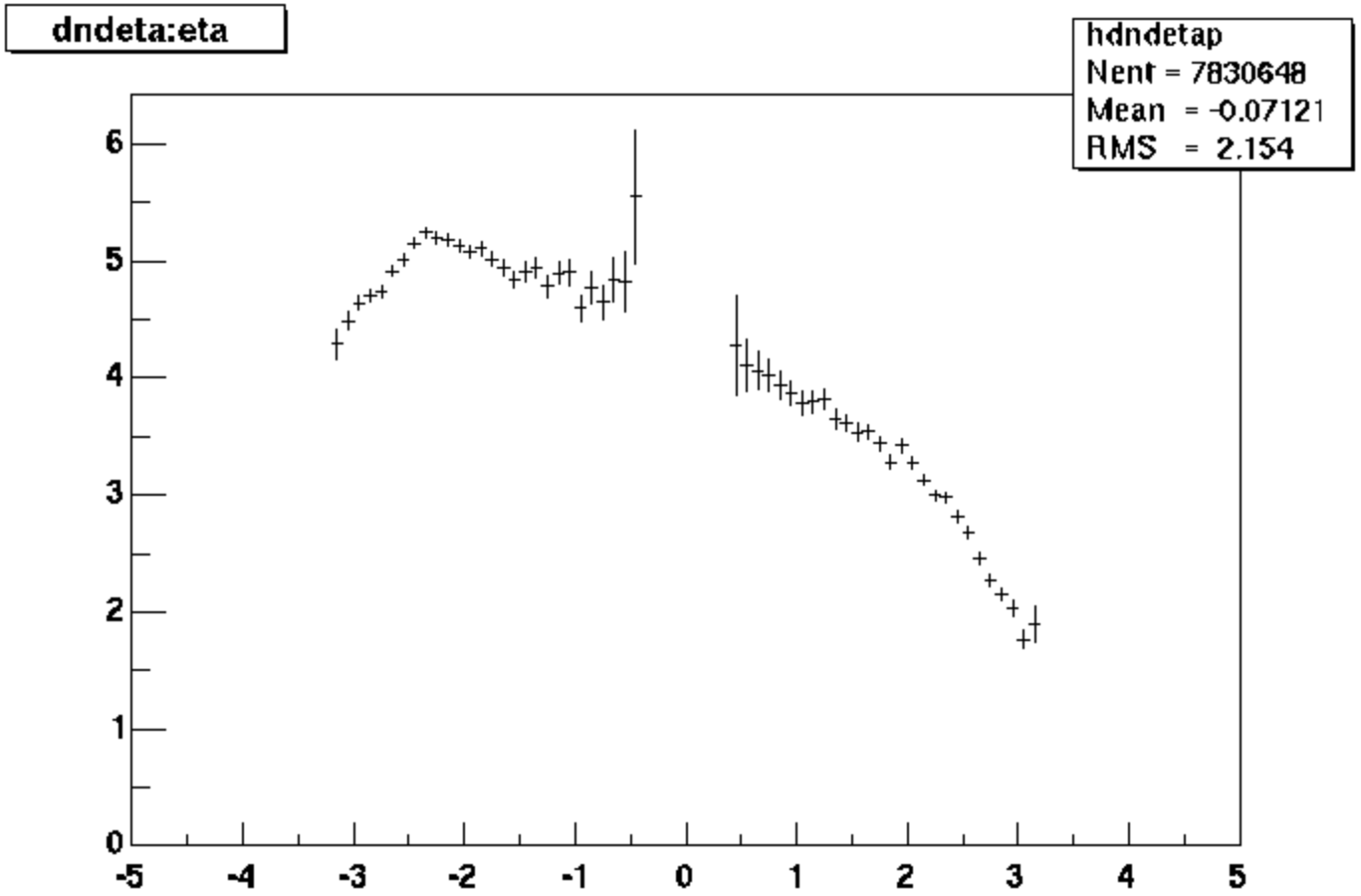
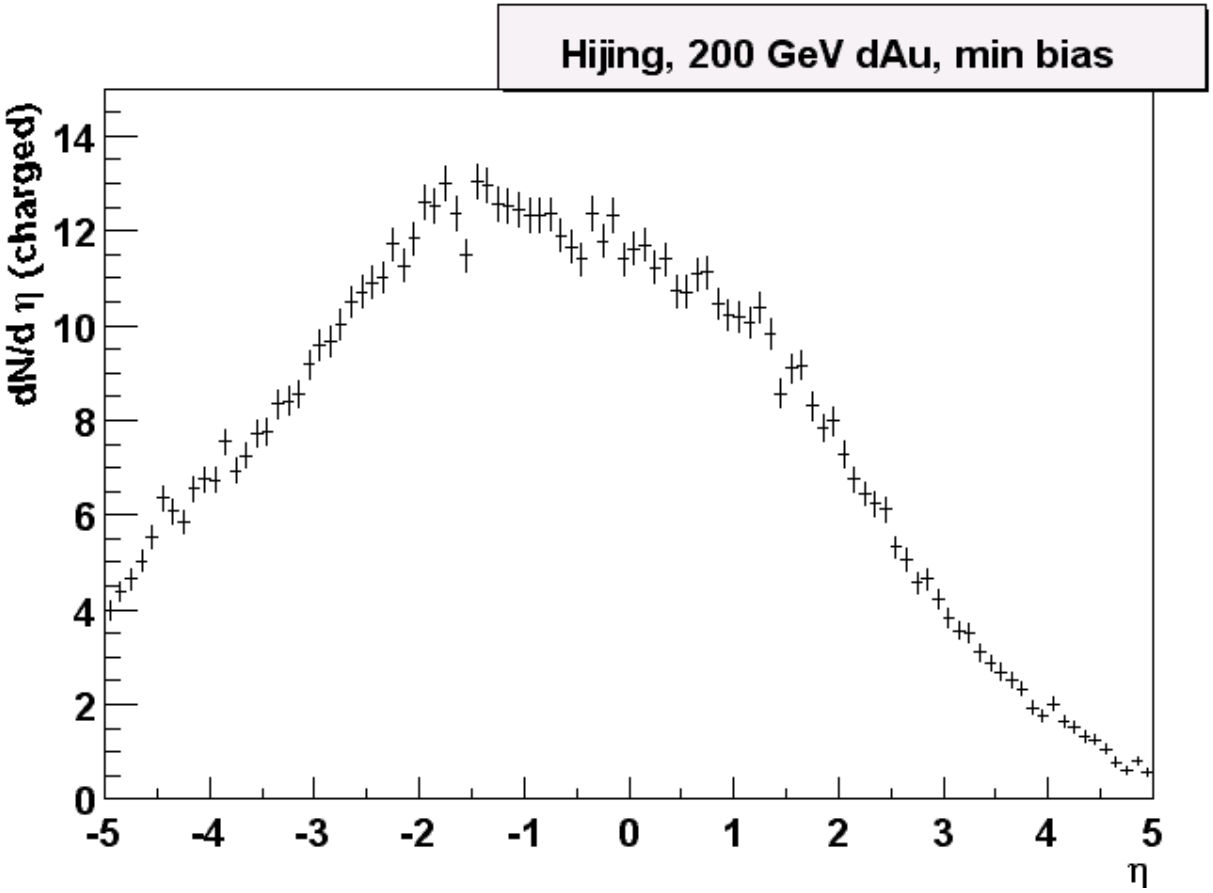
d+Au dN/dh from SangSu Ryu (from MVD pads)



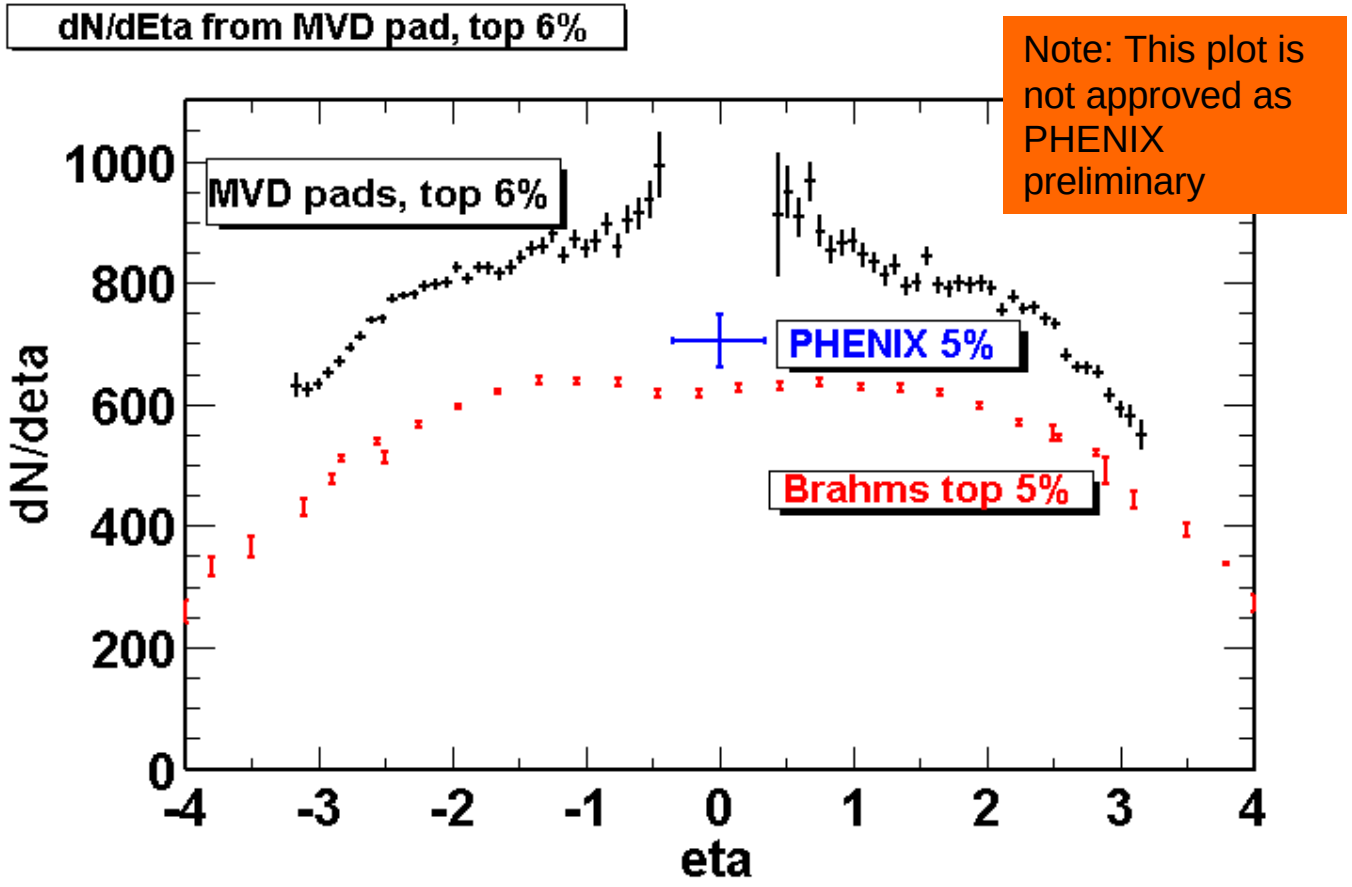
Minimum bias d+Au, using pad detectors, not "rigorously checked for possible programs bugs. So there is plenty of possibility for improvement. It also needs serious simulation efforts." -- from SangSu's email 2-Jun-2003.

Hijing d+Au dN/deta



MVD dN/dh

This plot comes from the work of Sangsu Ryu and Ju Kang at Yonsei. dN/dη is calculated from the MVD pads which had the best resolution in the year-2 run.



From Ken Barrish

--Work from Wei in 2000.
--Fairly detailed simulation of the MVD response

pulse height cut plus a 10 deg separation cut rejects:
68% of the Dalitz decay electrons
75% of the beam pipe conversion electrons
While keeping 78% of signal electrons from charm and bottom.

Useful for a ΔG measurement using single electrons

Wei's PWG talk on Sep 14th, 2000:

http://www.phenix.bnl.gov/phenix/WWW/trigger/pp/c-arm/mtg000914/Wei/index.html

(main result for Dalitz/conversion rejection is on page 12)

Mainly relevant for pp, pA collisions